THE

PHYSIOGRAPHY

OF

THE UPPER ENGADINE.

BY

FRANCIS LLOYD.

WITH MAP AND DIAGRAMS.

LONDON:
EDWARD STANFORD, 55, CHARING CROSS, S.W.
1881.

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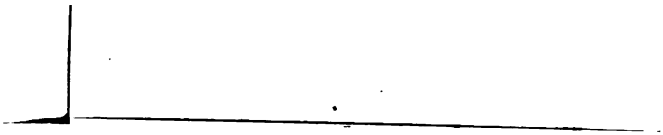

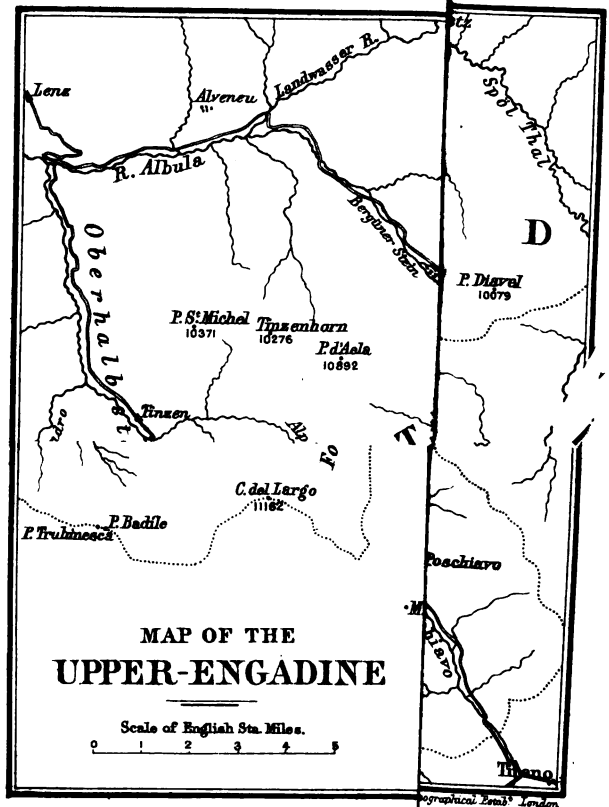
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MAP OF THE
UPPER-ENGADINE
Scale of English Sta. Miles.
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PREFACE.

I HAVE visited Pontresina every season for the last eight years, staying there on an average two months in each year.

In my rambles, walks, and climbs, I have been led to speculate on the phenomena which came under my eyes. Each successive year I saw features which had previously escaped my observation.

I print these few pages under the impression that they may interest visitors who may be more competent than I am, to read Nature's riddles, and in the hope that thus a more perfect tale may be told.

F. L.

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THE

PHYSIOGRAPHY

OF

THE UPPER ENGADINE.

THE Upper Engadine is remarkable for its valleys —their width, their height above the sea (about 6000 feet), and for their being surrounded by mountain ranges, which have numerous peaks (at least thirty) rising from 4000 to 7000 feet above them.

Hence it offers an unusually favourable field for studying, and for speculating on, the physical changes which the Alpine regions have undergone.

The Upper Engadine extends down the Inn Valley, nearly to Zernetz, but I propose to treat mainly of that part which is above Samaden. The geographical area thus limited is bounded on the south by the Bernina range from P. della Margna to P. Sassal Masone; on the east, by the mountains

which are at the head of Val Minor and Val del Fain; on the north and north-east, by the range extending west and north-west from P. Stretta, comprehending P. Albris, P. Languard, P. Muraigl, and the southern slopes of the spur of P. Vadret, which divides the Val Champagna from Val Muraigl. The north-west boundary extends from P. Padella to P. Julier, and thence to P. Lunghino, which overhangs the Maloggia, and the Val Bregaglia. The south-west boundary extends from P. Lunghino, to P. della Margna; the area comprised is about 160 square miles.

Since the great ice ages, the whole of this area, except the Lago Bianco and the mountains around it, has been drained by the Inn, but previously, during the great glacial periods, the ice-stream in the Upper Inn Valley flowed south-west as well as north-east. The evidence of this is conclusive. Glaciers wear and smooth all angularities and prominences which oppose their progress, but ice, being nearly rigid, does not bend round rocky steps which have their faces towards the direction in which the ice flows. Hence projecting rocks which have been traversed by a glacier resemble a boat turned bottom upwards, with the prow in the direc-

tion that the ice flowed *from*, while the stern is in the direction that the ice flowed *to*.

On the plain near Celerina there is a mass of rock *in situ*, a quarter of a mile long, and one-eighth of a mile broad, rising to the height of 150 feet, which has withstood the power of the glaciers. The church of St. Gian stands on the south-west end of this, near the pointed end, while at the north-east end, towards the lower valley, it is precipitous. Now, at Sils Maria, in front of the hotel Alpen Rose, there is a similar mass of rock presenting the same features as Munt St. Gian, but with the pointed and blunt ends reversed.

Other instances might be given to prove that the glacier stream flowed in two directions from some point between Sils and St. Moritz. An inspection of the valley (or of the map) between these places will show that the narrowest part is near Campfer. Crest Alta, which projects into the lake of that name, and rises to the height of 300 feet above the lake, is connected by comparatively high ground to a spur of P. Surlei. Hence I infer that a line drawn from P. Albana to P. Surlei will mark the ice-shed during the great glacial period.

The glaciers of the greatest ice period reached to

the height of 8400 feet s. m., or 2400 feet above Pontresina. The P. Ot range, as seen from Pontresina, shows very distinctly a line above which are jagged peaks, and below which the mountain slopes are rounded and more or less grass covered. Crasta Mora, on the north side of the Bevers Thal, shows the same, as does also the shoulder of P. Padella. P. Muraigl, as seen from the Roseg Valley, has the same feature well marked, and is also much furrowed. These are conspicuous instances, but all the mountains show the same, with more or less distinctness.

Erratic boulders, more or less ice-worn, are found on the mountains at about 8400 feet s. m., giving clear evidence of the height to which the glaciers reached. Theobald says, that on the Muottas da Samaden there are erratics which must have come from Munt Pers, about seven miles distant.

Erratic blocks may be found above 8400 feet s. m., but these are not rounded at the edges, as they were borne from the higher mountains on comparatively thin ice streams, which were tributaries to the valley glaciers.

At the height mentioned, striated and furrowed rocks are abundant.

On the mountain sides there are pasturages, called

by natives "Alps," which afford scanty food to cattle and sheep in the summer. These extend upwards from the height of 7200 feet s. m. to 8400 feet s. m., and are the outcome of the grinding of the mountain slopes during the greatest glacial period. Among the many instances of these, the following may be cited: the Languard Alp, the Munt della bescha (above Pontresina) the Muottas da Samaden, the Schaafberg above Samaden, the Alps Giop and Nova, above St. Moritz, Alp la Motta, above the Silvaplana See, on the east, the Muottas da Celerina, on the shoulder of P. Rosatsch, the Muottas da Pontresina, on the shoulder of P. Chalchagn. There are "Alps," also, on the west sides of the Roseg Glacier and of the Morteratsch Glacier.

It sometimes happens that there is a fall of snow in the Engadine valleys in the middle of summer. On such occasions the snow will remain for a day or two, as low down as 8400 feet s. m., marking very distinctly the line of the glaciers when they were at their greatest size. Owing to the rough surfaces of the mountains above this line, the fresh snow is partially sheltered from the sun's rays and from the warm winds, while lower, owing to the comparative smoothness of the mountains, it soon melts.

The great ice period has left another evidence of its power. P. Muraigl faces a line drawn down the centre of the Roseg Valley, and in like manner P. Albris presents its face to a similar line drawn down the upper Morteratsch Valley. In both these instances the mountains are scarred and precipitous in a marked degree at the parts where the present glacier line prolonged would impinge on the mountain. The base of P. Padella, between Celerina and Samaden, is semicircular in form, and is remarkably precipitous and broken. The great stream of ice which flowed from the Bernina pass must have moved directly on this point. The ice streams from the Morteratsch and Roseg valleys were diverted, as before stated, by the mountains opposite to them, and therefore the united force of these, and of the Bernina Glacier, would act on the base of P. Padella, and that probably originated the configuration which now exists.

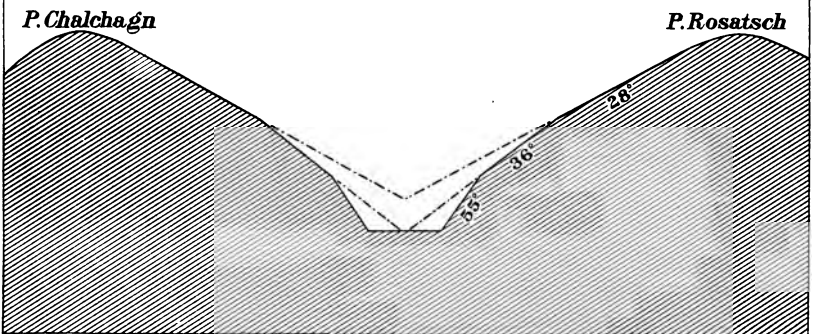
Viollet le Duc says: "There can be no question that the glacial epoch was divided into two periods, with an interval between, during which the present fauna and flora, mingled with a few extinct varieties, took possession of the Alps."

Herr, in his 'Primeval Switzerland,' expresses the

A.

SECTION OF THE ROSEG VALLEY
2¼ Miles from Pontresina

To show the probable ice wear in the two great ice periods.



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Stanford's Geogl Estabt London.

same opinion. It is thought that this second ice period lasted longer than the first, although the glaciers were not so large.

It has been already said that the glaciers of the first period reached to the height of 8400 feet s. m., and that pasturages exist between this height and 7200 feet s. m. Below the latter height, and down to the level of the valleys (another 1200 feet), the mountain sides are much more precipitous, except where taluses, or recent moraines, prevail. Very generally, the 1200 feet space between 6000 and 7200 feet is clothed with fir-trees, which so rarely grow above the latter height, that the highest line of tree growth may be taken as a measure of height.

The profile of P. Rosatsch, as seen from Pontresina, and even better from the Muottas da Celerina, shows three distinct gradients, the second being steeper than the first, while the third and lowest is steeper than the second. The breaks in the gradients coincide with the 8400 feet and 7200 feet heights. *

The same configuration may be traced on the profiles of the mountains which bound other valleys, but in many cases it is obscured by remains of

* See Diagram A.

moraines, and by debris and berg-falls of recent date.

Is it unreasonable to suppose that the depth of the valleys before the first glacial period would be figured by prolonging the topmost gradients, and, in like manner, the depth of the valleys afterwards by prolonging the second gradients? The space between the latter and the present bed of the valley, on such a supposition, would be the result of the second glacial period, altered, however, by the work of later glaciers, by the action of water, and by continuous disintegration.

The moraines of the glaciers of the first period were carried far beyond the present valleys by the glaciers of the second period, as these had a depth of 1200 feet. The terminal moraines of these must have been left beyond the valleys of the Upper Engadine, but we may expect to find traces of the lateral moraines. At the mouth of the Roseg Valley, on the right bank, on the shoulder of P. Chalchagn, there is moraine reaching to the height of over 600 feet. This is, I believe, the remains of the lateral moraine of the second glacial period. Abutting upon it, and extending some distance up the Morteratsch Valley, there is a similar deposit,

which I think is of the same date. In the same category I should place the enormous boulders lying on the mountain side (S.), within half a mile of the Morteratsch Glacier snout.

Pontresina stands on the remains of a large moraine which has undergone much change and diminution. This moraine was left by the Roseg Glacier. At the mouth of the Roseg Valley, and in various parts, from Pontresina to near Samaden, there are boulders of Talkschiefer (talcose slate), a kind of rock which is found only on the mountains which bound the present Roseg Glacier, and on part of Agagliouls. These boulders are disappearing, as they are the only ones that can be worked to use as coping and flagstones.

These remains appear to mark a third glacial period, when the ice in the valleys had a depth of about 300 feet. It is impossible to estimate the interval of time between it and the previous one, but the size of the moraine indicates that the glacier must have been stationary for many years.

At two miles up the Roseg Valley, where it is narrowest, and where the road is very near to the river, there is, on the left bank, an immense pile of moraine, having a base of 1000 yards, and rising to

the height of 220 feet above the valley. Originally this moraine extended across the valley, which, at the height of 7200 feet s. m., has a width of nearly half a mile.

Above this remarkable moraine the valley is considerably wider. Various masses of moraine are dotted about in the manner which is usual when a glacier is receding.

At about two miles farther up the valley there is another large moraine. This has a base of about 1000 yards, and rises to the height of 350 feet above the valley. Like the one before spoken of, it once reached across the valley, which, at 7200 feet s. m., is nearly three quarters of a mile wide.

Both these moraines are clothed with firs, and, as seen from Pontresina, appear as hills.

The distance from the last mentioned moraine to the snout of the existing glacier is about a mile and a half. The valley is here nearly level, but at the sides of it there are remains of moraines.

I have traced the glacial remains in the Roseg Valley. I purpose now to do the same in the others.

The Bernina Valley joins that of the Morteratsch near the point to which the snout of the

Morteratsch Glacier now extends. But in the first and second ice periods, the glaciers from these valleys must have flowed in a united stream as far as the mouth of the Roseg Valley, the glacier from which must there have joined the others.

A short distance above Giarsun the Morteratsch Valley is very narrow, being only 600 yards wide, while the mountains on each side are remarkably precipitous. On each side of the valley, particularly on the left, there is a large mass of moraine which extends to that deposited by the Roseg Glacier on the north-eastern flank of P. Chalchagn.

It no doubt originally extended across the valley, and was hindered from further progress by the terminal moraine of the Roseg Glacier, with which I assume it to be contemporaneous. It deserves to be noted that a small part of the mountain on the right bank above the moraine is composed of the same granite as P. Chalchagn.

About two miles up the valley from Pontresina, where its width is considerable, there is on the right bank a large moraine deposit, much of which is arranged in the semicircular form common to terminal moraines when deposited in an open space. Some of this may be seen in section from the opposite

side of the valley. On the left bank, moraine is piled up at the base of P. Chalchagn, while in the middle of the valley it is overlaid by moraine from a small glacier on the upper part of Chalchagn; it has also been acted on by water.

This deposit of the united Bernina and Morteratsch glaciers is probably of the same date as the large moraine two miles up the Roseg Valley.

As in that valley, so in this, we come next to small moraine deposits till near the head of the valley. As the glaciers retreated, that from the Bernina no longer joined the one from the Morteratsch. The low spur of Munt Pers, which presents a fine expanse of ice-worn rock, formed a division between the two.

At three miles up the valley from Pontresina, at the base of P. Albris, there is a great accumulation of moraine, and opposite to this, on the other side of the valley, but higher up, there is a large deposit of moraine, remarkable for the size of the boulders.

No doubt these two deposits formed part of one large moraine which reached across the valley, and the middle part has been carried away by water. As the glacier diminished, the spur of Munt Pers would deflect it to the left side of the valley.

These deposits are probably contemporaneous with the enormous moraine four miles up the Roseg Valley.

In the Bernina Valley there is much moraine, reaching from the northern base of Munt Pers to above the Bernina Houses.

The valley from Campfer to Samaden does not exhibit the same distinct evidence of halts in the retreat of the glacier that we find in the other valleys. This is not surprising if we consider that this valley is shorter, and much wider, than the others. But at the base of the Muottas da Samaden, which is on the north side of the Val Muraigl, there is an extensive moraine deposit, rising to 300 feet above the valley. It seems highly probable that this is of the same date as the deposits at, and near, Pontresina.

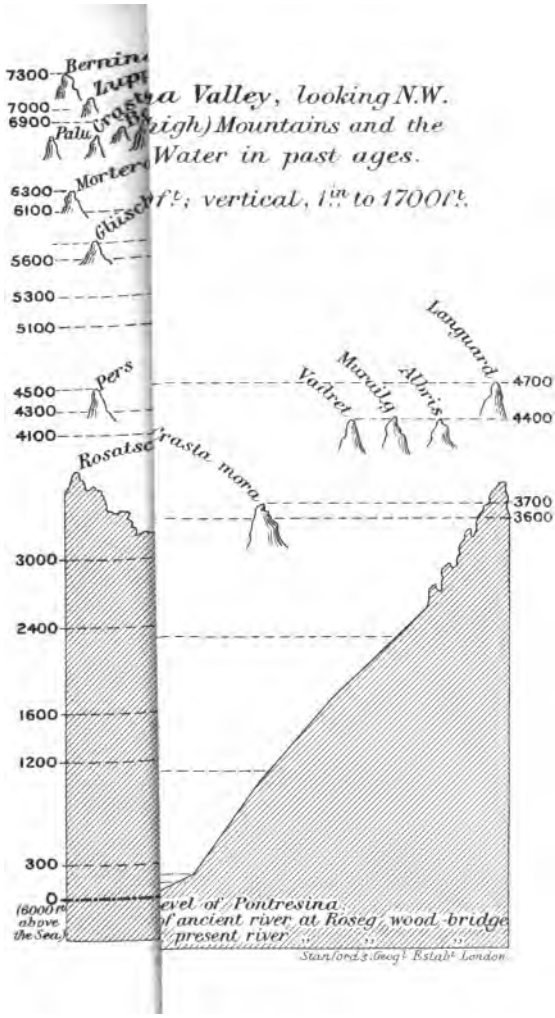
The triangular promontory between the Inn (after it leaves St. Moritz Lake) and the Flatzbach, an area of a square mile, is covered with moraine, in some parts much heaped; it has also many erratic boulders. Here we appear to have a deposit of the date of that which is two miles up the Roseg Valley.

On the flank of P. Rosatsch, overhanging the Kurhaus, St. Moritz, and 500 feet above it, there is a

well defined and large moraine, and on the opposite side of the valley there is moraine covering the flank of P. Nair, extending from the main axis of the Val Suvretta nearly to St. Moritz Dorfli. There is a correspondence in the height of these, which is 6300 feet s. m. It seems highly probable that these are contemporaneous with the vast moraine at the head of the Roseg Valley.

A striking, though small instance, tending to confirm the idea that after the two great ice periods there were three others, of less, but still considerable, duration, is presented by the Val Muraigl. This small valley has now at its head an insignificant glacier, lying on the north face of P. Muraigl. From this comes a small but rapid torrent. Now, the sides of this torrent (the south side especially) are bordered by lateral moraines of great size, which extend nearly to the Flatz-bach. Above the Châlet on the right side of the valley there is a remarkable ridge on the mountain side, up which there is a steep path. This is part of a moraine which at one time reached across the valley.

About a mile further up this valley, at the spot where there is a cattle-fold, another well marked moraine may be seen. Thus we have in this small


Valley, looking N.W.
Mountains and the
Water in past ages.
ft; vertical, 1in to 1700ft.
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7000
6900
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4500
4300
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Languard
4700
4400
Vadret
Murailg
Albris
Pers
Rosatsch
Trasta mora
3700
3600
(6000ft above the Sea)
evel of Pontresina
of ancient river at Roseg, wood bridge
present river
Stanford's Geogl Estabt London

valley three separate moraines, corresponding with those already spoken of in the other valleys.

The several lakes of Sils, Silvaplana, Campfer, and St. Moritz are separated by low tracts of land, each of which is in the line of a lateral valley prolonged. At Campfer, we have the mouth of the V. Suvretta; at Silvaplana, the valley beside which the road from the Julier Pass descends, and a small valley on the opposite side at Surlei; at Sils, there is the mouth of the Fex Valley; and on the south side of the lake of Sils, the mouth of the Fedoz Valley shows an encroachment on the lake. These interruptions to the continuity of one large lake, which probably at some time existed, can hardly be deltas of the rivers, but appear to be the result of moraines deposited by glaciers from the several lateral valleys during the third ice period.

P. Muraigl, which overhangs Pontresina, has a spur which extends in a north-west direction, and forms the left side of the Val Muraigl. On the base of this spur, nearly to the extremity of it, there are several taluses, some of which extend far into the valley. The first impression is that they are berg-falls, but it may be noticed that the size bears no relation to the height of the cliffs above, as it should

do if they were berg-falls. It may also be noticed that in each instance there is a gully, or depression, on the upper shoulder of the mountain wherever one of these taluses is observable. The largest and highest of these is that behind Pontresina, and it stands out as a sort of promontory, rising to the height of 250 feet. There are twelve of these; they are all terraced, and farther on I shall remark on this fact.

The form, the position, and the material of these taluses justify the opinion that they are small moraines of the third ice period. At this day there are small glaciers in the basins below the upper peaks of P. Muraigl, P. Chalchagn, P. Rosatsch, and other mountains. When glaciers occupied the lower parts of the valleys, probably to the depth of 300 feet, the shoulders of the mountains must have had ice-streams flowing over them, fed by the glaciers in the basins spoken of. These, of course, carried the usual load of rocky debris, supplied by the upper peaks, and the ice-streams naturally flowed down any depressions or gullies. On looking upwards from the top of the one behind Pontresina, the channel by which the ice flowed from the basin of P. Muraigl may be distinctly seen. The same

remark applies to the one near the old church, the Val Languard having been its source.

P. Chalchagn presents a remarkable instance of this deposit of moraine from the shoulder of a mountain. Below the present small glacier on it there is a well-marked depression, on the side towards the Roseg Valley, and the same towards the Morteratsch Valley. The mass of moraine which lies two miles up the Roseg Valley, on the right bank, is surmounted by an extensive talus rising to a great height. At a corresponding position in the Morteratsch Valley the same may be observed, perhaps even on a larger scale.

I have traced the retreat of the glaciers to a distance up the valleys approximating to their present position. What I have called the fifth ice period appears to have been succeeded by one in which water took the place of ice in the lower parts of the valleys. I have mentioned particularly a talus behind Pontresina, which I consider to be a moraine from a glacier which flowed from the basin of P. Muraigl. The rounded top of it is 250 feet above Pontresina, the axis is in the direction of, and its extreme end reaches to, the garden of the White Cross Hotel. It has ten distinct terraces, and

similar terracing occurs on the other taluses. Above Samaden, Celerina, and Campfer, on the base of the P. Ot range, there is the same terracing.

The highest terraces at Pontresina agree in level with those in other parts of the valleys. Hence I conclude that they mark the greatest height of a lake which extended up all the valleys; in the Inn Valley up to the Maloggia Pass, in the Roseg Valley to Alp Prima, and in the Morteratsch Valley to the present snout of the glacier. Without doubt, the hand of man has been busy with these terraces since the water shaped them roughly. The boulders which probably remained on the surfaces when the waters retired were either built up in the risers, or were removed, and piled up as heaps or walls.

The length of this lake, from the Morteratsch Glacier to Val Muntatsch, above St. Peters at Samaden, would be over seven miles, while its width from above Pontresina to St. Moritz would be nearly four miles. Yielding soil, such as glacier mud, would be washed away, and the unsupported boulders would settle down as terraces. But a considerable lapse of time is necessary to form one of these terraces, and as they are numerous it must be inferred that there were many partial subsi-

dences of the water, with long intervals of time between them.

The form of the terraces on the taluses below the Roseg Hotel indicates that the water which acted on them flowed from the Roseg Valley and the mountains which bound it. The direction of these is about 25° W. of S. It seems highly improbable that there should have been a persistent wind from this quarter for the number of years that would be necessary to form the terraces. These considerations point to the probability that at the end of the third glacial period the temperature rose sufficiently to melt the snow and ice which rested on the mountains and in the valleys, this melting going on for many consecutive years, and that the water poured directly down on the small moraines.

The terraced promontory behind Pontresina, and that near the path to the Languard Alp, indicate that the water that formed the terraces flowed from a direction about 15° W. of S. Now, these were not exposed to the direct action of the flow from the Roseg Valley and mountains. The stream from the latter, combined with that from the Morteratsch Valley and mountains, would be such as to give the

configuration we find in the terraces. The terraces above St. Moritz, Celerina, and Samaden, are shaped consistently with a flow of water from the Upper Inn Valley.

Where were the barriers which confined the lake, and of what were they made up? At Zernetz, the valley of the Inn makes an abrupt turn, and is very narrow as far as Süss. It is likely that at this part moraine would accumulate during the third glacial period. A similiar action is likely to have gone on at the south end of the lake of Sils. If we suppose these barriers to have been sapped from time to time, we have an explanation of the succession of terraces.

All the valleys indicate a violent irruption of water at some time. "Belvair," the plain opposite to Pontresina, has undoubtedly been subject to great water force, which has swept before it all but the most ponderous boulders. The large moraines of the fourth and fifth ice periods in the Roseg Valley have been cut through, while some of the smaller moraine heaps have had all the glacier mud washed away.

Perhaps, while the great lake was gradually draining, the moraines of the third and fourth ice periods, at the mouths of the lateral valleys, upheld

the waters above them, until the pressure became beyond their powers of resistance, and they suddenly yielded.

It may be asked if the evidences I have stated of a first and second ice period are to be found in other parts of Switzerland. When the valleys are narrow, and particularly when the mountains which bound them are composed of a rock which readily disintegrates, the sides of the valley show in the main a uniform angle. But in wide valleys, the comparatively precipitous slopes of the lower parts of the mountains, and, above these, the grazing alps of a lower angle, are general. They may be seen in the Linthal; in the valleys of the Upper Rhine, the Rhone, the Bregaglia, the Adda, the Adige, the D'Illiez, and many others. St. Beatenburg, 2000 feet above the lake of Thun, is a comparatively flat shelf, extending for some miles, and is of the same nature.

The moraine deposits in the above and in other valleys are so numerous, and in many cases so confused by the confluence of lateral valleys, that it is very difficult to attribute them to any given ice period. But the general disposition of them tends to confirm the theory of three ice periods since the two great ones.

GLACIAL EPOCH.

WHAT was the cause of the glacial epoch, and what the date of it?

Dr. Croll, in his 'Climate and Time,' attributes the glacial epoch to the excentricity of the earth's orbit. He is of opinion that the glacial period ended 80,000 years ago, having lasted 160,000 years. He considered that the glacial epoch consisted of a long succession of alternate cold and warm periods, the cold periods of not more than 10,000 or 12,000 years each.

Mr Wallace, in his 'Island Life,' 1880, while agreeing generally with Dr. Croll, as to the cause and date of the glacial epoch, thinks that change in the distribution of land and water combined to produce the glacial epoch. He also adopts the opinion that there were certainly two, and probably

several more, alternations of arctic and temperate climates.

Dr. J. Geikie, in his 'Great Ice Age,' considers that he has shown that Dr. Croll's theory is the only one which explains the phenomena of the glacial period. In his 'Prehistoric Europe' he states that he considers we have evidence in England of four glacial epochs, separated by intervening epochs of mild climatic conditions.

He says also: "Now, a close analysis of the glacial deposits of the mountainous regions and northern latitudes of Europe demonstrates that the ice age was not one long continuous period of arctic conditions. It was interrupted several times—how often we cannot yet say—by interglacial epochs of mild and genial conditions."

Viollet le Duc, writing on glacial action, says: "There were, however—and this we consider a point to be insisted on—periods of decrease more or less gradual, but uninterrupted, succeeded by a condition which maintained itself without either serious diminution or augmentation.

"There were, after the culmination of the second glacial epoch, great thaws during a certain lapse of

time; then a halt—a second period—during which the ice preserved a constant level; then a third period—a fresh halt—and so on up to historical epochs."

Liebig, treating of a certain interglacial lignite bed, estimates that 9600 years must be allowed for its formation.

EXTRACTS FROM JOURNEY NOTE-BOOK.

Ponte to Süss.

Ponte.—Above this place there is a large moraine traversed by the Albula route. Terraces reach to about the height of 500 feet above the Inn Valley, and on both sides of it.

Following the Albula route, upwards from the level at which trees end, to within one mile of the col, the mountain sides on the south side present the appearance of ridge and furrow, as if they had been traversed by a gigantic plough. This feature extends up to the bases of the higher peaks, and is the work of the glaciers during the greatest ice period.

Above *Madulein* the mountain side is conspicuously scarred. This is opposite to the Chiamuera Valley, which without doubt contributed a considerable

glacier, which was met by another from the Albula Pass. The conflict between these and the glacier of the Inn Valley probably broke up the face of the mountain as it now is.

Near *Capella* there is a huge moraine which appears to have been left by the glaciers which issued from the Trupchum and Casana valleys on the right and from the Sulsanna Valley on the left, all which here join the Inn Valley.

This moraine is about half a mile long, and more than 100 feet in height. It is probably of the same date as those at the mouths of the higher Engadine valleys.

Other lateral valleys, down to Zernetz, have moraine deposits at their mouths. At *Cinuschel* there is a large moraine opposite to the mouths of the Tarta and Punt Auta valleys. At *Brail* also, opposite to the Mela Valley.

Zernetz.—Here there are moraines on the right and left of the valley, as well as a large lateral moraine from the valley down which the Spel flows.

Along the whole length of the Inn Valley, to this point, distinct terracing is observable at intervals, mostly on the left side.

Süss.—From Zernetz to Süss, the valley bends

abruptly to the north, and is very narrow, particularly near the latter place, where a mountain spur projects nearly across it. Immediately below this spur the Fluela Pass enters the valley of the Inn, and must have borne a glacier with a moraine which was deposited at its end. All these conditions combine to make it probable that, after the third ice period, when water took the place of ice, here was the barrier which dammed up the waters, and formed the large lake in the Upper Engadine. The sides of the mountains between Zernetz and Süss show ice grinding very distinctly.

Maloggia to Castasegna.

The lake of Sils is bounded on the south by a low and narrow tract of land of a marshy character. There is every appearance of mountains of some size having stood here in past ages. They were probably worn down by a glacier which flowed from the Lake of Campfer as well as by another from the Val Muretto.

The descent from the Maloggia into the Val Bregaglia is remarkably precipitous. Above *Casaccia*,

the first village in the valley, there is a huge moraine. This seems to have been left by glaciers which came from the Val Muretto, and from the long valley on the right.

Near *Raticcio* there is much moraine, widely distributed. Here there are lateral valleys on the right and left, the upper part of that on the left being occupied by the Albigno Glacier.

Between *Stampa* and *Promontogno*, in the middle of the valley, there is a vast moraine, a mile and a quarter long and three-quarters of a mile broad, and of great depth. A church stands on this moraine. The valley is here of great width, and is bounded by high mountains. A great part of this moraine probably dates from the third ice period, but I think it possible that some of it may belong to the second. At its highest part, this large accumulation bears the appearance of a lake bed. Just above Promontogno, a spur of the mountains on the left almost touches the mountain on the right. No doubt there was a time when they were joined. Moraine accumulated here may have made a dam, which led to the formation of a lake higher up the valley.

South of Promontogno is the *Val Bondasco*. It

begins at the large and high mountains of which P. Badili is the highest. This valley, like larger ones, has one or more grazing alps, and must have held a considerable glacier. At a prolongation of its axis, the mountain on the right of the Val Bregaglia shows a marked instance of scarred surface, which I attribute to the impact of a glacier from the Val Bondasco.

One mile below Promontogno, on the mountain side, about 1000 feet above the river, is *Soglio*. Below this village there is a fine chestnut forest which grows on a large and deep moraine, doubtless deposited by ancient glaciers from the Val Bondasco and from the steep slopes of the mountain above Soglio.

At *Castasegna* there is a good deal of moraine, which appears to have come from the valleys on the right and left of the main one.

Bernina Pass to Botzen, &c.

Two miles below the top of the pass is *La Rosa*, where there is a large moraine, and one mile lower is *Pesciadella*. Here the valleys Agone and Campo

meet, the latter being joined by the tributary valleys of Mera and Viola-Poschiavino. Together they have an area of twelve square miles, and are bounded by high mountains.

In the main valley, near Pesciadella, there is an enormous accumulation of moraine, which I attribute to the third ice period. In the Val Campo there is a wide distribution of moraine, and about midway between the two ends there is the appearance of an enormous wall of boulders resting on the native rock. This extends across the valley, and once formed a dam which confined a considerable lake.

This valley has great grandeur, and I think it likely that a painstaking examination might show deposits indicating the fourth and fifth ice periods.

At the lower end of the Poschiavo lake there is, on the rock *in situ*, a vast moraine which has been cut through by the river.

At *Campo Cologno*, there is a large moraine from a mountain dip and basin on the right.

From *Grosetto*, to above *Tiolo*, the river runs through moraine deposits, about 30 feet deep;

further on, the valley is narrowed by a buttress from the mountains on the left, while stretching out from the right is a huge moraine, some 200 feet high, through which the river has cut its way.

Baladore is an amphitheatre, in which the river makes an angle with its course above and below. The general level is not materially above that of the valley below the moraine last spoken of.

About half a mile short of *Morignone* there is again a large moraine. *Bormio* is in a vast amphitheatre, into which several valleys open. The whole area is covered with rock debris, but no formed moraines are observable.

At *Bormio Bagni*, the opening of the Val Viola shows a large moraine of great height, through which the river has cut its way. At one part there are many bare stones. Probably a great burst of water has at some time washed away all the fine matter.

The *Stelvio Pass*, as far as *Confine*, like most of the passes, has only irregular deposits of moraine. From *Confine* to *Prad*, with a few exceptions, the valley is V-shaped, in parts only wide

enough for the river and the road. At *Stilfs* there are lateral valleys on the left, and an immense accumulation of moraine, rising to 800 feet above the river. Near to the junction of the road with the valley of the Adige there is much moraine. Before Meran is reached, grazing alps may be observed at the height of 500 feet, and less distinctly at 1000 feet up.

Near *Meran*, the Adige makes a sudden bend southwards, and a rocky promontory, 500 feet high, extends from the mountains on the north. When the glaciers had retreated to about this part of the valley they deposited a vast quantity of moraine here. "Schloss Tirol" stands on a moraine at the height of 850 feet above the river. It is reached by a tunnel through a great mass of moraine.

Just below the junction of the Eisach with the Adige, south of Botzen, and on the right side of the river, there is an immense tract of country composed of moraine and sedimentary deposit. The lower parts of the mountains on the left between Botzen and Mori Station show ice wear more distinctly than any corresponding length of mountain I have noticed in Switzerland.

The largest ancient moraine I have seen is in the Sarco Valley, between Dro and Le Sarches, north of the Largo di Garda. It is about three miles long, and two miles wide. Mr. Ball seems to think it is a berg-fall, but it appears to me to have all the characteristics of moraine.

MOUNTAIN BASINS, MORAINES, STRIÆ, ETC.

PIZ MURAIGL is seen to great advantage at about half a mile up the Roseg Valley. It shows a large basin below its peak. This formation is also conspicuous in the mountains of the P. Ot range, and in many others. It is very remarkable in the large number of mountains which are seen from the Riffell near Zermatt. In some instances, as on P. Rosatsch, P. Chalchagn, and others, these basins have small glaciers in them. Now how do these basins arise? The small glaciers in some of them would lead to the idea that they are the *cause*, but perhaps they are rather the *effect*.

Perhaps the mountains, as we now see them, are but small remains of what they were in the greatest ice periods, and possibly glaciers then flowed from more

elevated peaks, down the mountain sides, and tore away the most disrupted and least cohesive parts.

Those who are not familiar with glacial phenomena think that glacierists are too ready to imagine every accumulation of rocks to be moraines, and to consider as erratic boulders masses of rock which have fallen direct from the mountains.

An hour spent in examining the débris lying near and below the snout of the Morteratsch Glacier will be full of instruction. There may be seen masses of rock of various kinds and sizes, a few with the angles and sides as sharp as if they had lately fallen from the mountains, others with the angles rubbed off, so that on passing the hand over them they feel comparatively smooth, though otherwise they show but little wear; others, again, which are smoothed over all their faces and angles, though not rounded like river-worn stones.

The river which issues from the glacier has commonly low but precipitous banks. If these be examined near the glacier they will be found to be made up of the above, imbedded in what is called glacier mud, which is in fact the small pieces and fine powder worn off the larger pieces of rock. Not unfrequently masses of rock in one or other of these

forms may be seen imbedded in the face of the glacier.

An hour on the glacier will show the process by which the rocks are worn as described. Narrow crevasses may be seen with rocks within their jaws, in some cases far down. Occasionally the glacier may be seen giving forth on the surface rocks which had been imbedded in it, and the mass of rock matter making up the medial moraine will be found to comprise unworn, slightly worn, and much-worn rock, with a great deal of glacier mud.

The wear of the rock-pieces arises from friction against each other or against the rock bed during the continued movement of the glacier.

Striated and polished rock-pieces may be sometimes seen, but they are comparatively rare; a large and fine instance of the latter is to be seen at the spot where tourists begin the descent to the glacier from the mountain side.

Striæ abound on the margins of existing glaciers, and on the rocks near the tops of the passes, as at the Bernina, but they are rarely seen elsewhere above 6500 feet s. m. It is probable that those now visible were not the work of the glaciers of the

first and second ice periods, but of the glaciers of the third ice period. Although these were small compared with those that preceded them, the rocks traversed by the latter were in the third period covered with shallow tributary glacier streams flowing from reservoirs higher up, which had perhaps sufficient weight to obliterate previous striæ, but not enough to make new ones. On the passes there were probably thick glaciers during the third and later ice periods.

ICE-TABLES.

THESE abound on glaciers. They are seen to the best advantage early in the summer.

Pieces of rock which fall from the mountains bounding a glacier are sometimes isolated on the surface of the ice. A piece a foot square or larger will not transmit the sun's heat to the ice under it. Hence as the sun melts the unprotected surface of the ice, the stone is left standing on an ice pedestal. When the pedestal attains some height the stone forms an imperfect protection from the sun's rays, and the pedestal is gradually melted. As the sun has the greatest power about noon, the south side of the pedestal melts most, while the north side melts but little. The east and west sides melt less than the south. As the summer advances the stones slip from their pedestals always towards the south, but sometimes inclining east or west, according to

the relative height of the mountains on the eastern or western boundaries of the glacier.

It is noticeable that small stones imbed themselves in the ice. Their size is insufficient to hinder the transmission of heat, while the sides, which have a large surface in proportion to the mass, reflect the sun's rays to the ice around.

ICE-CONES.

HUNDREDS of persons go on, and many traverse, the Morteratsch Glacier every summer. Guides and others hardly ever call attention to the ice-cones, which are curious objects of nature's handiwork, and are frequently of great beauty. They are most abundant near the base of the medial moraine, frequently covering a superficies of 200 square feet, with a height of 5 or 6 feet, and sometimes present a perfect model of an Alpine range, with peaks valleys, and rivers.

The conditions under which they are formed are remarkable. During the summer the surface of the glacier melts rapidly, as much as 3 inches in a single sunny day. The water resulting from this melting carries with it the dust and small pieces of stone which were entangled in the ice. This water in its course reaches a depression in the

glacier, where it accumulates, and where the dust and stones settle. The surface of the glacier is constantly changing its form, and in a comparatively short time the depression is drained of its water, the solid matter being left on the surface. This protects the ice from the sun, meanwhile the melting is going on around, and thus a hillock is formed. As the ice around this wastes, some of the accumulated dust and stones slide down the sides of the hillock, hence the ice surface covered by it is daily increased, at last forming a cone of ice, with only a thin skin of dust and stones, frequently not more than half an inch thick.

It is difficult to account for the striking similitude of these ice-cones to an Alpine range. I should attribute it to the unequal thickness and coherence of the dust and stones, leaving some parts of the ice less protected than others. If this is the explanation, we have the sun doing on the ice what water does on the earth in forming most of our valleys.

I have several times made ice-cones on a small scale by collecting some dust and stones and placing them on a slightly raised part of the glacier in the form of a small cone. In a few days I have

had a large *ice*-cone, covered with a skin of dust and stones.

The Muottas da Celerina is on the northern shoulder of P. Rosatsch. Being above the 1200 feet level, only a few separate firs are to be seen growing, but there are not a few dead ones of a size corresponding to an age exceeding 100 years.

Till of late years, the firs were probably all self-sown, and as none are now growing where these ancient ones flourished, it would seem that the climate during the last century has been more severe than it was previously.

MOVEMENT OF THE MORTERATSCH GLACIER.

The following is from the 'Geological Magazine,' No. 198.

"SIR,—In the month of August 1875, a friend and I agreed to get an approximate measurement of the rate of movement of this glacier. With this object we walked from the glacier snout, along the mountain side, on the left, till we saw a large boulder on the medial moraine, and also a rock *in situ*, on the mountain side on the right, at about the same level. We then found a spot on the left side, on looking from which we got the boulder and the rock *in situ* in line. As these were of considerable size (the boulder being about 80 cubic feet), we painted a strong line on each of them, and set up a post at the stand-point. This was about three furlongs above the snout of the glacier. Here the glacier

is about half a mile wide, the large boulder on the medial moraine being 500 yards from the left side, or stand-point.

"To estimate the movement, one person went on the moraine, near the boulder, while another was posted at the stand-point, and the latter signalled to the former to move to the right, or left, till he got to a spot which lined with the rock *in situ*. This was marked, and the distance to the boulder was measured.

"In 1875 three observations were taken, two at intervals of ten days and one at twenty-four days.

"My friend has not been in the Engadine since. I have been here every year since. In 1877, 1879, and this year, I have measured the progress of the boulder, in the manner described.

"The result is as follows:—

The average daily movement in

2 years	Aug. 1875	to	Aug. 1877,	was	1·48	in.
2 years	„ 1877	„	1879,	„	1·22	in.
1 yr. and 9 days,	„ 1879	„	1880,	„	1·28	in.
5 yrs. and 9 days,	„ 1875	„	1880,	„	1·34	in.
44 days,	7th Aug. 1875	to	20th Sept. 1875,	„	2·07	in.

"During the five years the glacier has diminished very considerably, especially in its depth. This

may account for the slower movement in the last three years. During the past year the boulder has been at a part of the glacier which is steeper than where it was previously. This may explain the slightly accelerated movement during the last year. I do not rely implicitly on the forty-four days' observation, but if it be assumed to be correct, it leads to the inference that the movement in summer is 2 inches per day, and in winter 1 inch.

"In the first four years there was no perceptible disturbance of the position of the boulder on the sustaining ice. During the last year it has twisted a little.

"Last summer I took some observations to ascertain the superficial waste of the glacier on a part which was free from moraine (during fine sunny weather), and found it amount to about 3 inches per day. This summer I have again taken observations, in a different manner, extending over 21 days; these gave a result of over 2 inches per day.

"Forbes states that the waste is as much as 3 inches a day in a hot summer. Now, on comparing the scale of movement with that of the waste by melting, I get results which I cannot reconcile.

"The boulder which I have had under observation

cannot have come from any mountain which is less than three miles distant from its present position. The angle of the glacier above the part where it rests is less, rather than greater. I therefore assume that the recorded rate of movement may be taken as an average, in which case the boulder must have been travelling 400 years.

"The depth of the glacier is probably not more than 300 feet, but I will assume it to be 600 feet, and that the average waste is only 2 inches a day, during three summer months, or fifteen feet per annum. On this assumption the whole depth of 600 feet would be melted in forty years. I have taken observations of the relative movement of the glacier where covered with moraine, and also where free from it. They do not encourage the supposition that there is any material difference.

"F. LLOYD.

"19*th August*, 1880."

"THE FISH."

PONTRESINA commands a fine view of the P. Ot range of mountains as far south-west as P. Julier. The base of this mountain and St. Moritz are hidden by the shoulder of P. Rosatsch.

On many evenings, at about the hour of sunset, a curious and interesting phenomenon is to be seen in the direction spoken of.

A well-defined, narrow cloud of considerable length, which is popularly known as "The Fish," owing to its form, may be seen drifting from the valley between the shoulder of P. Rosatsch and P. Julier, moving continuously at considerable speed, but vanishing before it gets as far as the base of P. Ot. This will last for an hour, or more. The impression on the minds of those who see it is that it comes from the St. Moritz Lake, but that is not the case; it is formed at the base of P. Julier, and is to be seen only when the wind is from the south-west.

The explanation of the phenomenon is this. To the north-east of P. Julier is the Suvretta Thal, surmounted by some small glaciers lying on the side of P. Julier. Neither the Thal nor the glaciers get the sun upon them for more than a short time in the early morning. With a south-west wind the air is charged with much moisture. When this air reaches P. Julier it becomes chilled by the cold of the glaciers and of the Suvretta Thal. In consequence of this it will no longer hold as invisible vapour all the moisture, and the excess is condensed and takes the form of a cloud. When this cloud comes near the base of P. Ot it is under the influence of the sides of the mountains which have had the sun on them for the greater part of the day. These mountain sides continue to radiate the heat they have acquired, even after the sun's rays have left them, and such is the power of this radiated heat that it warms the air sufficiently to enable it to take up, or dissolve in it, the passing cloud.

By going up to Crast' Ota the formation of the cloud above the Val Suvretta may be seen.

"The Fish" is thought to be a sign of rain, and its appearance is frequently, but not invariably, followed by a change of weather.

THE GORGE.

PROFESSOR TYNDALL says, in 'Fragments of Science,' 6th edit. p. 285 :—

"At Pontresina, a very fine and instructive gorge is to be seen. The river from the Morteratsch Glacier rushes through a deep and narrow chasm, which is spanned at one place by a stone bridge. The rock is not of a character to preserve smooth polishing, but the larger features of water action are perfectly evident from top to bottom. These features are in part visible from the bridge, but still better from a point a little distance from the bridge in the direction of the upper village of Pontresina. The hollowing out of the rock by the eddies of water is here quite manifest."

* * * * *

"A little way below the junction of the two streams from the Bernina Pass and the Heuthal the

river flows through a channel cut by itself, and 20 or 30 feet in depth. At some places the river bed is covered with rolled stones; at others it is bare, but shows no trace of fissure. The abstract power of water, if I may use the term, to cut through rock is demonstrated by such instances. But if water be competent to form a gorge without the aid of a fissure, why assume the existence of such fissures in cases like that at Pontresina."

Again, at p. 295, he says: "I have hitherto confined myself to the consideration of the broad question of the erosion theory as compared with the fracture theory; and all I have been able to observe and think with reference to the subject, leads me to adopt the former. Under the term erosion I include the action of water, of ice, and of the atmosphere, including frost and rain. Water and ice, however, are the two principal agents, and which of these two has produced the greatest effect it is perhaps impossible to say."

Although in the last-quoted passage ice is included in the agents, the general tenor of the statement, and the particular reference to the marks of water-wear, lead to the conclusion that Professor Tyndall attributes the gorges to the action of water.

His remark that the larger features of water action are perfectly evident from top to bottom leads to the idea that such may be seen together in some parts. I have not seen any instance of this. In some places the smooth, concave surfaces which the continued action of water leaves are observable near the top of chasms, in other places at about midway between the top and bottom, and again near the bottom. The lateral branches of the chasm show no water wear.

The lower Grindelwald Glacier has receded much during the last fourteen years. The rock bed formerly covered by the glacier exhibits a cleft of about the depth and width of the Pontresina gorge. It shows some interesting features. The sides, for the greater part of it, have all the roughness of original fracture, but projecting parts have been smoothed like the glacier bed. Here and there, at the top, in the middle, and near the bottom, may be seen concave surfaces, the result of water wear. Some are of eccentric form. One is remarkably like the apse of a church, with the semi-dome artistically shaded, while above it is the half of a moulin-formed cylinder.

In previous pages I have stated the evidence of there having been five ice periods, followed by a lake

period. During three of the former, this, like other parts of the valley, must have been subject to the glacier movement, and at the disappearance of the lake there was without doubt a violent outburst of water. Fissures are not uncommon in mountainous regions, and rock masses are frequently in a highly disrupted state.

Considering all these facts, and the vast lapse of time since the valley was formed, it would appear to be impossible to say what agents formed the gorge. When the mountains were upheaved it is not improbable that the part of the valley in question consisted of much-broken masses of rock. These would have been acted on by the moving glaciers, and in and among them the water draining from the ice may have impinged with force on certain parts of the sides of what is part of the gorge.

It seems to me that the gorge is the result of the combined action of ice and water under various conditions, acting on an original fracture.

WALKS

NEAR

PONTRESINA,

NOT INCLUDING

Long Excursions or Mountain Ascents.

SHORT WALKS

FROM

PONTRESINA,

Mainly on the flat.

In all these walks, the village church is taken as the starting-point.

The time stated is for walking *one* way, at three miles an hour.

	Hrs.	Ms.
1. Punt Ota, the bridge over the Morteratsch river. Up the village and take the first road on the *right.*	0	5
2. The Gorge, as far as the branch path to the Steinbock Hotel . . . . . As 1, then take the path to the *left.*	0	16
3. Bridge in Morteratsch Valley, near the Cascade. As 2, then follow the path up the valley.	0	35
4. Rosellas, to the seat facing the Roseg Valley . As 1, then take the *path* on the right.	0	16
5. Tais * Plateau, where four paths meet . . As 1, then take the *middle* path.	0	12
6. Bridge (first) in Roseg Valley . . . . . As 4, then follow the wheel-track till a path on the *right* is reached.	0	45

* Tais is a path from 2 to 4—13 minutes.

	Hrs.	Ms.
7. Bridge (second) in Roseg Valley . . . . As 6, keeping on the wheel-track till "the open" is reached, where there is a steep path down to the river side.	1	5
8. Bridge (first) in Roseg Valley, by the *left* bank . As 1, then follow the road over the bridge across the Roseg River.	0	40
9. Bridge (second) in Roseg Valley, by the left bank As 8, following the road till the second bridge is reached.	0	50
10. The Gorge, by the high road . . . . . Take the high road up the village as far as the Steinbock Hotel, then through the turnstile and over the bridge. On reaching the wood, turn to the *right*.	0	30
11. Old Church and Tower . . . . . Up the village, taking the road on the *left* of the Languard Hotel.	0	12
12. Bridge, near the Cascade in the Morteratsch Valley Up the village by the high road, or as 11, taking the path behind the old tower and the Steinbock Hotel. This is 5 minutes longer.	0	25
13. Berguine . . . . . As 11, turn to the *left* at the old church, pass through the larch wood, and where the path divides take the downward one.	0	22
14. Bernina Falls, near the Morteratsch Glacier . As 12, then take the *path* beside the river. The best view of the glacier is got by keeping to the *road* as far as the higher zigzags. If the *river* be followed from this point to the Falls, several pretty falls and rapids may be seen. This requires 30 minutes more time.	1	15

	Hrs.	Ms.
15. Morteratsch Glacier Restaurant	1	30
As 14; or as 3, on the left bank, following the track farther. The last is 10 minutes longer.		
16. Chünetta (860 feet above Pontresina) . .	2	0
As 15, then take the path up the mountain on the left of the glacier. To descend to the glacier, leave the path at the last tree on the left. This is 350 feet above the restaurant, which is 220 feet above Pontresina.		
17. Belvair (the flat on the left of the river, opposite Pontresina)	0	15
Down the village to the Roseg Hotel, where take the path to the *left*, and go over the wood bridge; or, cross Punt Ota and the stone bridge over the Roseg River, and then turn to the *right*.		
18. The Statz Lake	0	40
As 17; on reaching the top of the bank take the *path* opposite to you, across Belvair.		
19. The Meierei (Acla d'im Lej)	0	50
As 18; at the Statz Lake take the path on the *right* along the north side of the lake. The Meierei is a farmhouse on the left of the path.		
20. St. Moritz	1	30
As 19; follow the path past the Meierei, and turn to the *right* (N.) at the side of the lake.		
21. St. Moritz-bad	1	45
As 20; when the lake is reached, take the path on the *left* (S.) side of it.		
22. Celerina, by the old road	1	15
As 18 as far as Belvair, then take the road on the right. Celerina is 330 feet below Pontresina.		

	Hrs.	Ms.
23. Celerina, by the woods	1	30
As 18; at the Statz Lake take the road on the *right*, away from the lake. This may be shortened by taking an indistinct old road on the right of the path, in the open, before the highest part of the road is reached.		
24. Celerina wood bridge	1	30
As 23 as far as the margin of the wood, then skirt the wood till a path by the right bank of the Inn is reached.		
25. Waterfall of the Inn, near St. Moritz Bridge .	2	15
As 24, then follow the path (good) through the woods on the right of the Inn Gorge.		

WALKS, WITH SOME CLIMBING.

	Hrs.	Ms.	Height above Pontresina. Feet.
26. The Schafberg	1	15	1235
Take the path at the side of the church. The seat on Crast' Ota is 410 feet, and that under the inclined rock 710 feet, up.			
27. Alp Languard	1	15	1250
As 11, then follow the track up the mountain to the Châlet. Continue on the same level to the head of the Languard Cascade.			
28. Muottas da Pontresina	1	15	1340
As 5, then take the middle path.			

	Hrs.	Ms.	Height above Pontresina. Feet.
29. Plaun da Statz	1	20	390
As 18; on reaching the Statz Lake take the road to the *left*, but go to the *right* where it branches.			
Or, across Punt Ota and the Roseg stone bridge, up the hillside opposite, where wheel-tracks may be seen for a certain distance. Then follow a rough track, which is also a water-course, and after a steep climb "Crasta" will be reached. Turning to the left, you will be at the *head* of the Plaun	1	30	500
30. St. Moritz-bad, by the Plaun da Statz	2	0	500
As 29; continue along the Plaun in the direction of P. Julier, through the wood beside a stream, and shortly a cart-track will be seen, which follow.			
31. Muottas da Celerina	2	30	1500
As 29; or, when at the *head* of the Plaun, strike upwards on the left by any practicable track.			
32. Roseg Valley Restaurant . . .	2	0	600
As 7 or 9, then follow the road. To reach the Glacier snout, continue up the valley on the left side. This will require 45 minutes more time.			

	Hrs.	Ms.	Height above Pontresina. Feet.
33. Alp Ota. . . . . As 32, then go on towards the glacier; about one mile beyond the restaurant there is a path leading to the Alp.	3	0	1760
34. Val Muraigl, first châlet in . . Down the village by the Samaden road for 1½ mile, near where the small river from the valley crosses the road. A track ascends on the right bank of the stream. Or, leave the high road at the first cart-track on the right. In due time the small river, and a foot-bridge across it, will be reached.	1	15	1140
35. Muottas da Samaden . . . . As 34; follow the track which goes up the valley for half a mile farther, and then up the mountain side to the upper châlet. The Stein-mann is 300 feet higher.	2	30	1950
36. Alp Laret . . . . . As 22; cross the high road through Celerina, mount by the road beside the stream till a branch to the left is reached, then follow that. The path may be made out to St. Moritz.	2	0	890
37. Val Saluver . . . . . As 36 as far as the branch path, then take the path in front beside the gorge.	3	15	2100

THE FOLLOWING MAY INTEREST TOURISTS AND METEOROLOGISTS.

The school of Pontresina (first floor) is a meteorological station. It is 6001 feet above the sea. Readings are taken three times a day, and are chalked on a board outside the building. Travellers should correct the readings of their aneroids by these.

BAROMETER READINGS AT PONTRESINA, AND AT SEA-LEVEL, IN MILLIMETRES AND INCHES.

WEATHER.	PONTRESINA.		SEA-LEVEL.		WEATHER.
	mm.	in. Eng.	mm.	in. Eng.	
—	623	24·53	787	31·0	Very dry.
Trocken . .	619	24·37	775	30·5	Set fair.
Schön . . .	615	24·21	762	30·0	Fair.
Veränderlich .	611	24·06	749	29·5	Change.
Regen . . .	607	23·90	737	29·0	Rain.
Sturm . . .	603	23·74	724	28·5	Much rain.
—	599	23·58	712	28·0	Stormy.

Settled fine weather cannot be relied on when the barometer reading is below 615 mm. = 24·21 inches.

It is noticeable that while the range of the barometer at Pontresina is ·95 inch, at sea-level it is 3 inches.

The mean summer temperature in the shade at Pontresina is, at 7 a.m. (Morg.) 45° Fahr.; at 1 p.m. (Mit.) 65° Fahr.; at 9 p.m. (Ab.) 55° Fahr.

LONDON: PRINTED BY EDWARD STANFORD, 55, CHARING CROSS, S.W.